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Multistage Transmission for An Internal Combustion Engine

The invention is based on a multistage transmission for an internal combustion engine in accordance with the features set forth in the preamble of Claim 1.

So-called dual clutch transmissions (see, for example, DE 100 38 090 A1) have been known in automotive engineering for many years and are increasingly used in the sports car sector to combine the lower fuel consumption and the sporty appearance of a manual transmission with the comfort of an automatic transmission. While the one train is used to drive the car, the next gear step can be preselected on the other train. The main attraction is the use of known and field-proven shift components (synchronization devices and clutches).

Based on function, the gear set arrangement for a dual clutch transmission is selected such that the even and odd gears are arranged on separate, specially provided input shafts. To be able to use such a dual clutch gear set for a conventional manual transmission (keyword: "same parts" principle) would require, for example, hydraulic control of the synchronization devices associated with the individual gears. With a traditional internal gearshift, the familiar H shift pattern in the manual transmission could not be implemented.

Thus, the object of the invention is to provide a shift control system for the gear set arrangement of a dual clutch transmission, which can be used to implement a conventional H shift pattern.

This object is attained by the features set forth in Claim 1.

With the inventive gearshift control system, a conventional manual transmission with an H shift pattern can advantageously be implemented despite a dual clutch gear set. This makes it possible to further increase the number of identical components for different transmission designs and to simultaneously reduce the production costs.

Other features embodying the invention are set forth in the dependent claims.

To control the shifting of the individual gears, a gate element equipped with the cable control or gearshift linkage is provided, and for each of the two shifter shafts a lever idler assembly whose one end is coupled to the gate element and the other end to the shifter shaft. The rotary motion of the shifter shafts, which is required to shift the even and odd gears, is thereby made possible in a very simple manner.

The rotary motion transmitted via the gate element and the corresponding idler system to the respective shifter shaft is effected via a pin arranged at the end of the idler assembly, which engages with a guide groove of a bushing disposed on the corresponding shifter shaft.

The shifter shafts have shift fingers that interact with shift openings of shift plates. The shift plates are integrally connected with shift forks, such that a rotary motion of the shifter shaft is converted to a linear motion of the selected shift plate.

The use of two shift fingers, axially and radially offset 180° on each shifter shaft and interacting with two shift openings in a shift plate, which are likewise offset 180° in relation to each other, makes it possible to shift the even or

odd gears in the same direction--corresponding to the H shift pattern--(even gears forward, odd gears back).

To preselect the corresponding gears a lever system is provided, which is connected to the cable control or the gearshift linkage and which is coupled to the two shifter shafts via a lever arm each. The lever system enables a linear motion of the two shifter shafts to preselect different shift tracks.

Advantageously the two main shifter shafts each have an associated locking bar, which is axially guided via the shifter shaft and has a locking structure for the non-selected shift forks.

Two exemplary embodiments of the invention will now be described in greater detail with reference to the drawing in which:

- FIG 1 shows a gear set arrangement of a dual clutch transmission,
- FIG 2 is a schematic representation of the inventive mechanical gearshift control system,
- FIG 3 is a perspective view of the gearshift control system,
- FIG 4 shows the gearshift control system in a front view,
- FIG 5 shows the gearshift control system in a side view,
- FIG 6+7 show a simplified representation of the shift and selection pattern of the gearshift device,
- FIG 8 shows a locking mechanism of the gearshift control system for non-selected shift forks,
- FIG 9-15 are schematic representations of gear change processes,
- FIG 16 is a schematic representation of a selection process,
- FIG 17 is a simplified representation of a second embodiment of the inventive gearshift device,
- FIG 18 is a detail view of the gate track for the second embodiment,

- FIG 19 shows a first shift position according to the second embodiment, and
- FIG 20 shows a second shift position according to the second embodiment.

FIG 1 shows the gear set arrangement of a 7-gear dual clutch transmission. The even gears 2-4-6 and the reverse gear R are arranged on a first input shaft 2 while the odd gears 1-3-5-7 are arranged on a second input shaft 4 disposed coaxially to the first input shaft 2.

To make this gear set arrangement accessible to a conventional H gearshift with tractive force interruption, a mechanical gear engagement system is required in addition to a rotationally fixed connection (e.g., through spline gearing) of the two input shafts 2 and 4. This shift control system will now be described in greater detail:

The forward gears G1 to G7 and the reverse gear R, which are arranged on the two input shafts 2, 4, are assigned (synchronization) clutches S1 to S4 (not depicted), which use four shift forks 6, 8, 10 and 12 to optionally establish a corresponding rotationally fixed connection between the selected speed gear and the input shaft 2, 4. The clutch S3 is responsible for shifting the even gears G2 and G4 and the clutch S4 for the gears G6 and R. For the odd gears the clutch S1 is responsible for the gears G1 and G3 and the clutch S2 for the gears G5 and G7. A first shifter shaft 14 is provided to shift the odd gears G1, G3, G5 and G7, and a second shifter shaft 16 is provided for the gears G2, G4, G6 and the reverse gear R. For the shifting of all the gears, for which a corresponding rotary motion of the shifter shafts 14 and 16 is required, a common gate element 18 is provided for the two shifter shafts 14 and 16. The gate element 18 has a lever element 20, to which a cable control or gearshift linkage connected to the gearshift lever of the vehicle is

coupled. The gate element 18 has two guide tracks 22 and 24 with which a guide pin 26 and 28 engages. The guide pins 26, 28 are each fixed to a first idler lever 30 and 32, which are components of an idler system 31 and 33 provided for the two shifter shafts 14, 16 and which are configured identically for the two shifter shafts 14, 16. At the other end of the first idler lever 30, 32 an additional guide pin 34 and 36 is arranged, which engages with an oblong hole 38 and 40 of a second idler lever 42 and 44. The two idler levers 42 and 44 each have a bearing eye 46 and 48, which is received in a bearing stud (not depicted) of a common bearing bracket 50 (see FIG 3). At their other end, the two idler levers 42 and 44 have a guide pin 52 and 54, each of which engages with a guide groove 56 and 58. The guide groove 56 and 58 is integrally formed from a bushing 60 and 62, which is non-rotatably connected to the shifter shaft 14, 16.

At the upper end of the two bushings 60 and 62 a second guide groove 64 and 66 is formed with which a guide pin 68 and 70 provided for the selector control engages. The two guide pins 68 and 70 are arranged at the ends of a lever element 72 supported in the center of a housing (not depicted). At the other end of the bearing axis 74 connected to the lever element 72 a selector lever 76 is arranged, which is connected with a cable control or a selector linkage.

The lower ends of the two shifter shafts 14, 16 are each provided with two shift fingers 78 to 84, which are arranged axially and radially offset 180°. To shift the individual gears, the shift fingers 78 to 84 arranged on the two shifter shafts 14 and 16 cooperate with the shift openings 88 made in the shift plates 86. As shown schematically in FIG 2, the shift plates 86 are integrally connected to the shift forks 6 to 12.

In the gearshift housing (not depicted), two shafts 90 and 92 are assigned parallel to the two shifter shafts 14 and 16 and are supported in the gearshift housing so as to be locked against rotation. At their one end, the shafts 90 and 92 have a fork-shaped claw 94 and 96, which encircles the walls of the two guide grooves 64 and 66 formed in the two bushings 60 and 62. At the other end of the two shafts 90 and 92, four locking pins 98 for four different locking positions—corresponding to the four possible shift tracks—are provided on each shaft for two shift plates, respectively. The locking pins 98 interact with the locking grooves 100 that are disposed in the shift plates 86, as will be explained in greater detail below.

The shift control system, which also includes a preselection of the corresponding gears, will now be explained in greater detail with reference to FIG 9 to 16:

By moving the shift lever in the H gate (1st gear) the lever element 20 is moved via the control cable or the gearshift linkage in the direction indicated in FIG 9. The shifter shaft 14 is rotated (see FIG 10) via the gate element 18, the idler system 31 and the bushing 60. This rotary motion is converted into a linear displacement of the shift fork S1 via the shift finger 78 (or 80?), which engages with the corresponding shift plate 86. This establishes a conventional rotationally fixed connection between the speed gear or the idler gear G1 and the gear shaft 4. While the first shifter shaft 14 executes a rotary motion, the shifter shaft 16 does not rotate in this state because of the course of the guide track 24.

When shifting up from the first to the second gear, the lever element 20 is displaced via the gearshift lever of the vehicle in the direction indicated in FIG 11 and 12. When a center position is reached (see FIG 11) the 1st gear is disengaged again. On the other hand, when the right end position

is reached (see FIG 12), the shifter shaft 16 is now correspondingly rotated because of the course of the guide track 24. This rotary motion establishes a rotationally fixed connection between the speed gear or idler wheel G2 and the gear shaft 2, analogous to the 1st gear.

To shift up from the second to the third gear, an axial displacement of the shifter shaft 14 is required because of the necessary switch in the shift track. This is accomplished by means of the selector lever 76, which moves both the shifter shaft 14 and the shifter shaft 16 to a new shift track (see FIG 16).

The shifting to the 3rd gear is effected analogously to the preceding gearshifts. As shown in FIG 13 to 15, the shift finger 80 opposite the shift finger 78 now engages with the associated shift opening 88 and establishes a rotationally fixed connection between the speed gear G3 and the gear shaft 4 by means of the rotary motion of the shifter shaft 14.

The remaining gears G4 to G7 and the reverse gear R are shifted and preselected according to the same pattern, as described above.

To prevent any unintended displacement of the non-engaged shift forks on the shift axis 102, the locking pins 98 provided on the two locking shafts 90 and 92 engage with the locking grooves 100 of those shift plates whose shift forks are not engaged (keyhole function), as shown by way of example in FIG 8. The shafts 90 and 92 are axially guided by means of the claws 94 and 96 via the shifter shafts 14 and 16.

FIG 17 schematically shows a second exemplary embodiment of the inventive shift control system, which works according to the same functional principle and is distinguished from the first

embodiment essentially by a modified gate element 18'. The gate element 18' has a linear gate guide track F, which receives the guide pin P that is connected to the control cable or the gearshift linkage. The guide pin P is furthermore received in two driver elements M1 and M2, which are a component of the two idler systems 31 and 33 described with reference to the first embodiment. When shifting from a neutral position N to one of the odd gears (see FIG 19) the guide track F forces the guide pin P into the driver opening of the driver element M1, such that one of the odd gears is engaged depending on the selected shift track, analogous to the first embodiment. As shown in FIG 20, when the odd gears are disengaged, the driver element M1 is moved back into the neutral position. If the guide pin P is moved back via the gearshift lever of the vehicle, the guide pin P switches to the driver opening of the driver element M2 and one of the even gears 2/4/6 or R can be engaged.